



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number: 0 395 775 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 03.08.94 (51) Int. Cl.⁵: H01J 61/44

(21) Application number: 89107939.4

(22) Date of filing: 02.05.89

The file contains technical information submitted
after the application was filed and not included in
this specification

(54) Phosphor composition used for fluorescent lamp and fluorescent lamp using the same.

(43) Date of publication of application:
07.11.90 Bulletin 90/45

(45) Publication of the grant of the patent:
03.08.94 Bulletin 94/31

(64) Designated Contracting States:
DE GB IT NL

(65) References cited:
GB-A- 2 003 657
US-A- 4 431 942

(73) Proprietor: Nichia Kagaku Kogyo K.K.
No. 491-100, Oka
Kaminaka-cho
Anan-shi Tokushima-ken(JP)

(72) Inventor: Itsuki, Yuji NICHIA KAGAKU KOGYO
K.K.
491-100, Oka, Kaminaka-cho
Anan-shi Tokushima-ken(JP)
Inventor: Ichinomiya, Keiji NICHIA KAGAKU
KOGYO K.K.
491-100, Oka, Kaminaka-cho
Anan-shi Tokushima-ken(JP)

(74) Representative: Schütz, Peter, Dipl.-Ing. et al
Dr. Dieter von Bezold
Dipl.-Ing. Peter Schütz
Dipl.-Ing. Wolfgang Heusler
Brillenner Strasse 52
D-80333 München (DE)

EP 0 395 775 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Description

The present invention relates to a phosphor composition used for a fluorescent lamp and a fluorescent lamp using the same.

Conventionally, an antimony-/manganese-coactivated calcium halophosphate phosphor is most widely used for a general illumination fluorescent lamp. Although a lamp using such a phosphor has a high luminous efficiency, its color rendering properties are low, e.g., a mean color rendering index $R_a = 65$ at a color temperature of 4,300 K of the luminescence spectrum of the phosphor and a mean color rendering index $R_a = 74$ at a color temperature of 6,500 K. Therefore, a lamp using such a phosphor is not suitable when high color rendering properties are required.

Japanese Patent Publication No. 58-21672 discloses a three component type fluorescent lamp as a fluorescent lamp having relatively high color rendering properties. A combination of three narrow-band phosphors respectively having luminescence peaks near 450 nm, 545 nm, and 610 nm is used as a phosphor of this fluorescent lamp.

One of the three phosphors is a blue luminescence phosphor including, e.g., a divalent europium-activated alkaline earth metal aluminate phosphor and a divalent europium-activated alkaline earth metal chloroapatite phosphor. Another phosphor is a green luminescence phosphor including, e.g., a cerium-/terbium-coactivated lanthanum phosphate phosphor and a cerium-/terbium-coactivated magnesium aluminate phosphor. The remaining phosphor is a red luminescence phosphor including, e.g., a trivalent europium-activated yttrium oxide phosphor. A fluorescent lamp using a combination of these three phosphors has a mean color rendering index $R_a = 82$ and a high luminous efficiency.

Although the luminous flux of such a three component type fluorescent lamp is considerably improved compared with a lamp using the antimony-/manganese-coactivated calcium halophosphate phosphor, its color rendering properties are not satisfactorily high. In addition, since rare earth elements are mainly used as materials for the phosphors of the three component type fluorescent lamp, the phosphors are several tens times expensive than the antimony-/manganese-coactivated calcium halophosphate phosphor.

Generally, a fluorescent lamp using a combination of various phosphors is known as a high-color-rendering lamp. For example, Japanese Patent Disclosure (Kokai) No. 54-102073 discloses a fluorescent lamp using a combination of four types of phosphors, e.g., divalent europium-activated strontium borophosphate (a blue luminescence phosphor), tin-activated strontium magnesium orthophosphate (an orange luminescence phosphor), manganese-activated zinc silicate (green/blue luminescence phosphor), and antimony-/manganese-coactivated calcium halophosphate (daylight-color luminescence phosphor). In addition, a lamp having $R_a \geq 95$ has been developed by using a combination of five or six types of phosphors. However, these high-color-rendering lamps have low luminous fluxes of 1,180 to 2,300 Lm compared with a fluorescent lamp using the antimony-/manganese-coactivated calcium halophosphate phosphor. For example, a T-10•40-W lamp using the antimony-/manganese-coactivated calcium halophosphate phosphor has a luminous flux of 2,500 to 3,200 Lm. Thus, the luminous efficiencies of these high-color rendering fluorescent lamps are very low.

It is an object of the present invention to provide a phosphor composition which is low in cost and high in color rendering properties and luminous efficiency, and a fluorescent lamp using this phosphor composition.

A phosphor composition of the present invention contains red, blue, and green luminescence components. The blue luminescence component contained in the phosphor composition of the present invention emits blue light by the excitation of 253.7-nm ultraviolet light. The main luminescence peak of the blue light is present between wavelengths 460 and 510 nm, and the half width of the main peak is 50 nm or more. The color coordinates of the luminescence spectrum of the blue component fall within the ranges of $0.15 \leq x \leq 0.30$ and of $0.25 \leq y \leq 0.40$ based on the CIE 1931 standard chromaticity diagram. Assuming that the spectral reflectance of a smoked magnesium oxide film is 100%, the spectral reflectance of the blue component is 80% or more at 380 to 500 nm. The mixing weight ratio of the blue luminescence component with respect to the total amount of the composition is specified within the region enclosed with solid lines (inclusive) in Fig. 1 in accordance with the color temperature of the luminescence spectrum of the phosphor composition. The mixing weight ratio is specified in consideration of the initial luminous flux, color rendering properties, and cost of the blue phosphor.

A fluorescent lamp of the present invention is a lamp comprising a phosphor film formed by using the above-described phosphor composition of the invention.

According to the phosphor composition of the present invention and the lamp using the same, by specifying a type and amount of blue luminescence phosphor in the composition, both the color rendering properties and luminous efficiency can be increased compared with the conventional general fluorescent

lamps. In addition, the luminous efficiency of the lamp of the present invention can be increased compared with the conventional high-color-rendering fluorescent lamp. The color rendering properties of the lamp of the present invention can be improved compared with the conventional three component type fluorescent lamp. Moreover, since the use of a phosphor containing expensive rare earth elements used for the conventional three component type fluorescent lamp can be suppressed, and an inexpensive blue luminescence phosphor can be used without degrading the characteristics of the phosphor composition, the cost can be considerably decreased compared with the conventional three component type fluorescent lamp.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

- 10 Fig. 1 is a graph showing the mixing weight ratio of a blue luminescence component used in the present invention;
- Fig. 2 is a view showing a fluorescent lamp according to the present invention;
- Fig. 3 is a graph showing the spectral luminescence characteristics of a blue luminescence phosphor used in the present invention;
- 15 Fig. 4 is a graph showing the spectral reflectance characteristics of a blue luminescence component used in the present invention; and
- Fig. 5 is a graph showing the spectral reflectance characteristics of a blue luminescence phosphor which is not contained in the present invention.

According to the present invention, a low-cost, high-color-rendering, high-luminous-efficiency phosphor composition and a fluorescent lamp using the same can be obtained by specifying a blue luminescence component of the phosphor composition.

A composition of the present invention is a phosphor composition containing red, blue, and green luminescence components, and the blue luminescence component is specified as follows. A blue luminescence component used for the composition of the present invention emits blue light by the excitation of 253.7-nm ultraviolet light. The main luminescence peak of the blue light is present between wavelengths 460 and 510 nm, and the half width of the main peak is 50 nm or more, preferably, 50 to 175 nm. The color coordinates of the luminescence spectrum fall within the ranges of $0.10 \leq x \leq 0.30$ and of $0.20 \leq y \leq 0.40$ based on the CIE 1931 standard chromaticity diagram. Assuming that the spectral reflectance of a smoked magnesium oxide film is 100%, the spectral reflectance of light at wavelengths of 380 to 500 nm is 80% or more. In addition, the mixing weight ratio of the blue luminescence component with respect to the total amount of the composition is specified within the region enclosed with solid lines (inclusive) connecting coordinate points a (5%, 2,500 K), b (5%, 3,500 K), c (45%, 8,000 K), d (95%, 8,000 K), e (95%, 7,000 K), and f (65%, 4,000 K) in Fig. 1 (the color temperature of a phosphor composition to be obtained is plotted along the axis of abscissa, and the amount (weight%) of a blue component of the phosphor composition is plotted along the axis of ordinate).

As the blue luminescence component, for example, the following phosphors B1 to B4 are preferably used singly or in a combination of two or more:

- (B1) an antimony-activated calcium halophosphate phosphor
- (B2) a magnesium tungstate phosphor
- 40 (B3) a titanium-activated barium pyrophosphate phosphor
- (B4) a divalent europium-activated barium magnesium silicate phosphor

Fig. 3 shows the spectral emission characteristics of the four phosphors, and Fig. 4 shows their spectral reflectances. In Figs. 3 and 4, curves 31 and 41 correspond to the antimony-activated calcium halophosphate phosphor; curves 32 and 42, the magnesium tungstate phosphor; curves 33 and 43, the titanium-activated barium pyrophosphate phosphor; and curves 34 and 44, the divalent europium-activated barium magnesium silicate phosphor. As shown in Fig. 3, according to the spectral emission characteristics of the phosphors B1 to B4, the emission spectrum is very broad. As shown in Fig. 4, the spectral reflectances of the four phosphors are 80% or more at 380 to 500 nm, assuming that the spectral reflectance of a smoked magnesium oxide film is 100%.

In addition, a phosphor having a main peak wavelength of 530 to 550 nm and a peak half width of 10 nm or less is preferably used as the green luminescence phosphor. For example, the following phosphors G1 and G2 can be used singly or in a combination of the two:

- (G1) a cerium-/terbium-coactivated lanthanum phosphate phosphor
- (G2) a cerium-/terbium-coactivated magnesium aluminate phosphor

Moreover, a phosphor having a main peak wavelength of 600 to 660 nm and a main peak half width of 10 nm or less is preferably used as the red luminescence phosphor. For example, the following phosphors R1 to R4 can be used singly or in a combination of two or more:

- (R1) a trivalent europium-activated yttrium oxide phosphor

(R2) a divalent manganese-activated magnesium fluogermanate phosphor

(R3) a trivalent europium-activated yttrium phosphovanadate phosphor

(R4) a trivalent europium-activated yttrium vanadate phosphor

The red and green luminescence components are mixed with each other at a ratio to obtain a phosphor
5 composition having a desired color temperature. This ratio can be easily determined on the basis of experiments.

10

15

20

25

30

35

40

45

50

55

Table 1 shows the characteristics of these ten phosphors preferably used in the present invention.

Table 1

Phosphor Classification	Sample	Name of Phosphor	Peak Wave-length	Half Width	Color Coordinate
				x	y
First Phosphor	B1	antimony-activated calcium holophosphate	480	122	0.233 0.303
	B2	magnesium tungstate	484	138	0.224 0.305
	B3	titanium-activated barium pyrophosphate	493	170	0.261 0.338
	B4	europtium-activated magnesium barium silicate	490	93	0.216 0.336
Second Phosphor	G1	cerium-terbium-coactivated lanthanum phosphate	543	Line	0.347 0.579
	G2	cerium-terbium-coactivated magnesium aluminate	543	Line	0.332 0.597
	R1	trivalent europium-activated yttrium oxide	611	Line	0.650 0.345
	R2	divalent manganese-e-activated magnesium fluogerminate	658	Line	0.712 0.287
Third Phosphor	R3	trivalent europium-activated yttrium phosphovanadate	620	Line	0.663 0.331
	R4	trivalent europium-activated yttrium vanadate	620	Line	0.669 0.328

55

A fluorescent lamp of the present invention has a phosphor film formed of the above-described phosphor composition, and has a structure shown in, e.g., Fig. 2. The fluorescent lamp shown in Fig. 2 is designed such that a phosphor film 2 is formed on the inner surface of a glass tube 1 (T-10•40W) having a

diameter of 32 mm which is hermetically sealed by bases 5 attached to its both ends, and electrodes 4 are respectively mounted on the bases 5. In addition, a seal gas 3 such as an argon gas and mercury are present in the glass tube 1.

5 Examples 1- 60

A phosphor composition of the present invention was prepared by variously combining the phosphors B1 to B4, G1 and G2, and R1 to R4. The fluorescent lamp shown in Fig. 2 was formed by using this composition in accordance with the following processes.

10 100 g of nitrocellulose were dissolved in 9,900 g of butyl acetate to prepare a solution, and about 500 g of the phosphor composition of the present invention were dissolved in 500 g of this solution in a 1l-beaker. The resultant solution was stirred well to prepare a slurry.

Five fluorescent lamp glass tubes 1 were fixed upright in its longitudinal direction, and the slurry was then injected in each glass tube 1 to be coated on its inner surface. Thereafter, the coated slurry was dried.

15 The mean weight of the coated films 2 of the five glass tubes was about 5.3 g after drying.

Subsequently, these glass tubes 1 were heated in an electric furnace kept at 600 °C for 10 minutes, so that the coated films 2 were baked to burn off the nitrocellulose. In addition, the electrodes 4 were respectively inserted in the glass tubes 1. Thereafter, each glass tube 1 was evacuated, and an argon gas and mercury were injected therein, thus manufacturing T-10•40-W fluorescent lamps.

20 A photometric operation of each fluorescent lamp was performed. Tables 2A and 2B show the results together with compositions and weight ratios. Table 3 shows similar characteristics of conventional high-color-rendering, natural-color, three component type, and general illumination fluorescent lamps as comparative examples.

25

30

35

40

45

50

55

Tale 2A

Exam- ple No.	Corre- lated Color Temper- ture (K)	Phosphor Mixing Weight Ratio										Initial Lumi- nous Flux (Lm)	Mean Color Render- ing Index (Ra)*		
		Blue				Green			Red						
		B1	B2	B3	B4	G1	G2	R1	R2	R3	R4				
1	2800	10				26		64				3760	88		
2	3000	12				25		63				3720	88		
3	3000	11				24		62		3		3680	88		
4	3000	10					26	62	2			3670	88		
5	4200	39				21		40				3500	88		
6	4200	37					22	41				3480	88		
7	4200	38				20		39	3			3470	89		
8	4200	37				19		38	3	3		3450	90		
9	4200	38				10	10	40	2			3470	89		
10	4200	39				10	11	36	4			3470	90		
11	4200	37					21	39		3		3460	89		
12	4200		18			25		57				3620	89		
13	4200		17				26	57				3590	89		
14	4200		17			24		56		3		3580	90		
15	4200		16				23	54	7			3540	92		
16	4200		18			15	10	57				3610	89		
17	4200			49		16		35				3530	89		
18	4200			47			17	36				3500	89		
19	4200			47		15		33		5		3480	91		
20	4200			48		15		33	4			3490	90		
21	4200				56	11		33				3550	91		

Tale 2A (continued)

Exam- ple No.	Corre- lated Color Temper- ture (K)	Phosphor Mixing Weight Ratio										Initial Lumi- nous Flux (Lm)	Mean Color Render- ing Index (Ra)*		
		Blue				Green			Red						
		B1	B2	B3	B4	G1	G2	R1	R2	R3	R4				
22	4200				54	12	34					3520	91		
23	4200				55	10	32	3				3480	92		
24	4200				55	10	32		3			3490	92		
25	4200	20	9		23		48					3550	89		
26	4200	20		24	18		38					3510	89		
27	4200	20			28	16	36					3520	90		
28	4200		9	25	20		46					3580	89		
29	4200		9	28	18		45					3590	90		
30	4200			24	28	14	34					3520	90		

* Method of calculating Ra is based on CIE, second edition.

35

40

45

50

55

Table 2B

Example No.	Correlated Color Temperature (K)	Phosphor Mixing Weight Ratio										Initial Luminous Flux (Lm)	Mean Color Rendering Index (Ra)*		
		Blue				Green			Red						
		B1	B2	B3	B4	G1	G2	R1	R2	R3	R4				
31	5000	55				16		29				3280	90		
32	5000	54					17	29				3260	90		
33	5000	53				15		27		5		3200	91		
34	5000	54				15		27	2	2		3210	91		
35	5000		28			21		51				3440	91		
36	5000		27				22	51				3410	91		
37	5000		26			10		49	3	3		3360	93		
38	5000		27			19		49	5			3380	92		
39	5000			65		9		26				3310	91		
40	5000			63			10	27				3290	91		
41	5000			64		8		25	3			3280	92		
42	5000			64		8		25		3		3290	92		
43	5000			63		5	3	24	3	2		3270	93		
44	5000				62	8		30				3450	92		
45	5000				61		9	30				3420	92		
46	5000				62	4	5	27	2			3390	93		
47	5000	27	14			10	9	40				3350	91		
48	5000	27		32		13		28				3290	91		
49	5000	27			31	12		30				3370	91		
50	5000	18	9	22		15		36				3340	91		
51	6700	70				7		23				2980	91		

Tale 2B (continued)

Exam- ple No.	Corre- lated Color Temper- ture (K)	Phosphor Mixing Weight Ratio										Initial Lumi- nous Flux (Lm)	Mean Color Render- ing Index (Ra)*		
		Blue				Green			Red						
		B1	B2	B3	B4	G1	G2	R1	R2	R3	R4				
52	6700	69				4	3	19	3	2		2950	93		
53	6700		42			13		45				3110	93		
54	6700		41			10	3	44	2			3080	94		
55	6700			83				17				2920	91		
56	6700				82			18				2960	93		
57	6700	35	20			10		35				3050	92		
58	6700		20	42		6		32				3010	92		
59	6700			42	41			17				2940	92		
60	6700	23	14		27	4	3	27	2			2980	94		

35

40

45

50

55

Table 3

Prior Art No.	Correlated Color Temperature (K)	Name of Lamp	Initial Luminous Flux (Lm)	Color Rendering Index (Ra)*
1	5000	High-color-rendering fluorescent lamp	2250	99
2	3000	"	1950	95
3	6500	Natural-color fluorescent lamp	2000	94
4	5000	"	2400	92
5	4500	"	2450	92
6	5000	Three component type fluorescent lamp	3560	82
7	6700	"	3350	82
8	3500	General lighting fluorescent lamp	3010	56
9	4300	"	3100	65
10	5000	"	2950	68
11	6500	"	2700	74

* Method of calculating Ra is based on CIE second edition

As is apparent from Examples 1 to 60 shown in Table 2, each fluorescent lamp of the present invention has an initial luminous flux which is increased by several to 20% compared with those of most widely used general illumination fluorescent lamps, and has a mean color rendering index (87 to 94) larger than those of the conventional lamps (56 to 74) by about 20. Furthermore, although the mean color rendering index of each fluorescent lamp of the present invention is substantially the same as that of the natural-color fluorescent lamp ($R_a = 90$), its initial luminous flux is increased by about 50%. In addition, although the mean color rendering index of each fluorescent lamp of the present invention is slightly lower than those of conventional high-color-rendering fluorescent lamps, its initial luminous flux is increased by about 50%.

It has been difficult to realize both high color rendering properties and initial luminous flux in the conventional fluorescent lamps. However, the fluorescent lamp of the present invention has both high color

rendering properties and initial luminous flux. Note that each mean color rendering index is calculated on the basis of CIE, Second Edition.

According to the phosphor composition of the present invention and the fluorescent lamp using the same, the color temperature can be adjusted by adjusting the mixing weight ratio of a blue luminescence component. More specifically, if the mixing weight ratio of a blue luminescence component of a phosphor composition is decreased, and the weight ratio of a red luminescence component is increased, the color temperature of the luminescence spectrum of the phosphor composition tends to be decreased. In contrast to this, if the weight ratio of the blue luminescence component is increased, and the weight ratio of the red luminescence component is decreased, the color temperature tends to be increased. The color temperature of a fluorescent lamp is normally set to be in the range of 2,500 to 8,000 K. Therefore, according to the phosphor composition of the present invention and the fluorescent lamp using the same, the mixing weight ratio of a blue luminescence component is specified within the region enclosed with solid lines (inclusive) in accordance with a color temperature of 2,500 to 8,000 K, as shown in Fig. 1. Furthermore, according to the phosphor composition of the present invention and the fluorescent lamp using the same, in order to realize high luminous efficiency and color rendering properties, the main luminescence peak of a blue luminescence component, a half width of the main peak, and color coordinates x and y are specified. When the x and y values of the blue luminescence component fall within the ranges of $0.15 \leq x \leq 0.30$ and of $0.25 \leq y \leq 0.40$, high color rendering properties can be realized. If the main luminescence peak wavelength of the blue luminescence component is excessively large or small, excellent color rendering properties cannot be realized. In addition, if the half width of the main peak is smaller than 50 nm, excellent light output and high color rendering properties cannot be realized. Moreover, the spectral reflectance of the blue luminescence component of the present invention is specified to be 80% or more with respect to the spectral reflectance of a smoked magnesium oxide film at 380 to 500 nm so as to efficiently reflect luminescence and prevent absorption of luminescence by the phosphor itself. If a blue luminescence component having a spectral reflectance of less than 80% is used, a phosphor composition having good characteristics cannot be realized.

As indicated by curves 41, 42, 43, and 44 in Fig. 4, an antimony-activated calcium halophosphate phosphor, a magnesium tungstanate phosphor, a titanium-activated barium pyrophosphate phosphor, and a divalent europium-activated barium magnesium silicate used in the present invention have reflectances corresponding to that of the blue luminescence component of the present invention. As indicated by curves 51 and 52 in Fig. 5, however, a divalent europium-activated strontium borophosphate phosphor (curve 51) and a divalent europium-activated strontium aluminate phosphor (curve 52) whose reflectances are decreased at 380 to 500 nm cannot be used as a blue luminescence phosphor of the present invention. As a blue luminescence component used in the present invention, inexpensive phosphors can be used in addition to phosphors containing rare earth elements such as europium.

Note that the composition of the present invention may contain luminescence components of other colors in addition to the above-described red, blue, and green luminescence components. For example, as such luminescence components, orange luminescence components such as antimony-/manganese-coactivated calcium halophosphate and tin-activated strontium magnesium orthophosphate, bluish green luminescence components such as manganese-activated zinc silicate and manganese-activated magnesium gallate, and the like can be used.

Claims

- 45 1. A phosphor composition used for a fluorescent lamp, comprising a red luminescence component; a green luminescence component; and a blue luminescence component, characterized in that said blue luminescence component emits blue light by the excitation of 253.7-nm ultraviolet light and has a main luminescence peak wavelength of 460 to 510 nm, a half width of the main peak of a luminescence spectrum of not less than 50 nm, color coordinates of the luminescence spectrum falling within a range of $0.15 \leq x \leq 0.30$ and $0.25 \leq y \leq 0.40$ based on the CIE 1931 standard chromaticity diagram, and a spectral reflectance of not less than 80% at 380 to 500 nm, when a spectral reflectance of a smoked magnesium oxide film is 100%, a mixing weight ratio of said blue luminescence component with respect to a total composition amount being specified within a region enclosed with solid lines connecting coordinate points a (5%, 2,500 K), b (5%, 3,500 K), c (45%, 8,000 K), d (95%, 8,000 K), e (95%, 7,000 K) and f (65%, 4,000 K) shown in Fig. 1 which are determined in accordance with a color temperature of the luminescence spectrum of said phosphor composition, and said green luminescence component has a main luminescence peak wavelength of 530 to 550 nm, and a half width of the peak of not more than 10 nm.

2. A composition according to claim 1, **characterized in that** a main luminescence peak wavelength of said red luminescence component falls within a range of 600 to 660 nm, and a half width of the peak is not more than 10 nm.
- 5 3. A composition according to claim 1, **characterized in that** said blue luminescence component contains at least one member selected from the group consisting of an antimony-activated calcium halophosphate phosphor, a magnesium tungstate phosphor, a titanium-activated barium pyrophosphate phosphor, and a divalent europium-activated barium magnesium silicate phosphor.
- 10 4. A composition according to claim 1, **characterized in that** a cerium/terbium-coactivated lanthanum phosphate phosphor and a cerium/terbium-coactivated magnesium aluminate phosphor are used as said green luminescence component singly or in combination.
- 15 5. A composition according to claim 2, **characterized in that** said red luminescence component contains at least one member selected from the group consisting of a trivalent europium-activated yttrium oxide phosphor, a trivalent europium-activated yttrium phosphovanadate phosphor, a trivalent europium-activated yttrium vanadate phosphor, and a divalent manganese-activated magnesium fluogermanate phosphor.
- 20 6. A fluorescent lamp having a phosphor film (2) containing a phosphor composition comprising:
a red luminescence component;
a green luminescence component; and
a blue luminescence component, **characterized in that** said blue luminescence component is excited by 253.7-nm ultraviolet light and has a main luminescent peak wavelength of 460 to 510 nm, a half width of a luminescence spectrum of not less than 50 nm, color coordinates of the luminescence spectrum falling within a range of $0.15 \leq x \leq 0.30$ and of $0.25 \leq y \leq 0.40$ based on the CIE 1931 chromaticity diagram, and a spectral reflectance of not less than 80% at 380 to 500 nm, when a spectral reflectance of a smoked magnesium oxide film is 100%, a mixing weight ratio of said blue luminescence component with respect to a total composition amount being specified within a region enclosed with solid lines connecting coordinate points a (5%, 2,500 K), b (5%, 3,500 K), c (45%, 8,000 K), d (95%, 8,000 K), e (95%, 7,000 K) and f (65%, 4,000 K) shown in Fig. 1 which are determined in accordance with a color temperature of the luminescence spectrum of said phosphor composition, and said green luminescence component has a main luminescence peak wavelength of 530 to 550 nm, and a half width of the peak of not more than 10 nm.
- 25 7. A lamp according to claim 6, **characterized in that** a main luminescence peak wavelength of said red luminescence component falls within a range of 600 to 660 nm, and a half width of the peak is not more than 10 nm.
- 30 8. A lamp according to claim 6, **characterized in that** said blue luminescence component contains at least one member selected from the group consisting of an antimony-activated calcium halophosphate phosphor, a magnesium tungstate phosphor, a titanium-activated barium pyrophosphate phosphor, and a divalent europium-activated barium magnesium silicate phosphor.
- 35 9. A lamp according to claim 6, **characterized in that** a cerium/terbium-coactivated lanthanum phosphate phosphor and a cerium/terbium-coactivated magnesium aluminate phosphor are used as said green luminescence component singly or in combination.
- 40 10. A lamp according to claim 7, **characterized in that** said red luminescence component contains at least one member selected from the group consisting of a trivalent europium-activated yttrium oxide phosphor, a trivalent europium-activated yttrium phosphovanadate phosphor, a trivalent europium-activated yttrium vanadate phosphor, and a divalent manganese-activated magnesium fluogermanate phosphor.

55 Patentansprüche

1. Leuchtstoff-Zusammensetzung für eine Leuchtstofflampe, mit einer rot lumineszierenden Komponente, einer grün lumineszierenden Komponente und einer blau lumineszierenden Komponente, dadurch

- gekennzeichnet, daß die blau lumineszierende Komponente unter Anregung durch ultraviolettes Licht der Wellenlänge von 253,7 nm blaues Licht emittiert, wobei die Wellenlänge des Hauptmaximums der Lumineszenz im Bereich von 460 bis 510 nm liegt, die Halbwertsbreite des Hauptmaximums des Luminesenzspektrums nicht kleiner ist als 50 nm, die Farbkoordinaten des Luminesenzspektrums innerhalb eines Bereichs $0,15 \leq x \leq 0,30$ und $0,25 \leq y \leq 0,40$ auf der Farbtafel der Norm CIE 1931 liegen und die spektrale Remission nicht kleiner ist als 80% bei 380 bis 500 nm, wenn 100% die spektrale Remission einer als Rauch abgeschiedenen Magnesiumoxidschicht ist, und wobei das Mischungsverhältnis der blau lumineszierenden Komponente bezüglich der Gesamtmenge der Zusammensetzung innerhalb eines Bereichs liegt, der umschlossen ist durch die in Fig. 1 gezeigten durchgezogenen Linien, welche die Koordinatenpunkte a (5%, 2.500 K), b (5%, 3.500 K), c (45%, 8.000 K), d (95%, 8.000 K), e (95%, 7.000 K) und f (65%, 4.000 K) verbinden, die bestimmt sind entsprechend einer Farbtemperatur des Luminesenzspektrums der Leuchtstoff-Zusammensetzung, und wobei die grün lumineszierende Komponente ein Lumineszenz-Hauptmaximum bei einer Wellenlänge im Bereich von 530 bis 550 nm hat und die Halbwertsbreite des Maximums nicht größer ist als 10 nm.
2. Zusammensetzung nach Anspruch 1, dadurch gekennzeichnet, daß die Wellenlänge des Lumineszenz-Hauptmaximums der rot lumineszierenden Komponente innerhalb eines Bereichs von 600 bis 660 nm liegt und die Halbwertsbreite des Maximums nicht größer ist als 10 nm.
3. Zusammensetzung nach Anspruch 1, dadurch gekennzeichnet, daß die blau lumineszierende Komponente mindestens einen ausgewählten Stoff aus der Gruppe enthält, die folgende Stoffe umfaßt: antimon-aktivierter Calciumhalogenphosphat-Leuchtstoff, Magnesiumwolframat-Leuchtstoff, titan-aktivierter Bariumpyrophosphat-Leuchtstoff und mit zweiwertigem Europium aktivierter Bariummagnesiumsilicat-Leuchtstoff.
4. Zusammensetzung nach Anspruch 1, dadurch gekennzeichnet, daß als besagte grün lumineszierende Komponente ein cer/terbium-koaktivierter Lanthanphosphat-Leuchtstoff und ein cer/terbium-koaktivierter Magnesiumaluminat-Leuchtstoff entweder einzeln oder in Kombination verwendet werden.
5. Zusammensetzung nach Anspruch 2, dadurch gekennzeichnet, daß die rot lumineszierende Komponente mindestens einen ausgewählten Stoff aus der Gruppe enthält, die folgende Stoffe umfaßt: mit dreiwertigem Europium aktivierter Yttriumoxid-Leuchtstoff, mit dreiwertigem Europium aktivierter Yttriumphosphovanadat-Leuchtstoff, mit dreiwertigem Europium aktivierter Yttriumvanadat-Leuchtstoff und mit zweiwertigem Mangan aktivierter Magnesiumfluorgermanat-Leuchtstoff.
6. Leuchtstofflampe mit einer Leuchtstoffsschicht (2), die eine Leuchtstoff-Zusammensetzung mit einer rot lumineszierenden Komponente, einer grün lumineszierenden Komponente und einer blau lumineszierenden Komponente enthält, dadurch gekennzeichnet, daß die blau lumineszierende Komponente durch ultraviolettes Licht einer Wellenlänge von 253,7 nm angeregt wird, wobei das Hauptmaximum der Lumineszenz bei einer Wellenlänge im Bereich von 460 bis 510 nm liegt, die Halbwertsbreite des Luminesenzspektrums nicht kleiner ist als 50 nm, die Farbkoordinaten des Luminesenzspektrums innerhalb eines Bereichs von $0,15 \leq x \leq 0,30$ und $0,25 \leq y \leq 0,40$ auf der Farbtafel nach der Norm CIE 1931 liegen, die spektrale Remission nicht kleiner ist als 80% bei 380 bis 500 nm, wenn 100% die spektrale Remission einer als Rauch abgeschiedenen Magnesiumoxidschicht ist, das Mischungsverhältnis der blau lumineszierenden Komponente bezüglich der Gesamtmenge der Zusammensetzung innerhalb eines Bereichs liegt, der durch die in Fig. 1 gezeigten durchgezogenen Linien umschlossen ist, welche die Koordinatenpunkte a (5%, 2.500 K), b (5%, 3.500 K), c (45%, 8.000 K), d (95%, 8.000 K), e (95%, 7.000 K) und f (65%, 4.000 K) verbunden, die bestimmt sind entsprechend einer Farbtemperatur des Luminesenzspektrums der Leuchtstoff-Zusammensetzung, und wobei die grün lumineszierende Komponente ein Lumineszenz-Hauptmaximum bei einer Wellenlänge im Bereich von 350 bis 550 nm hat und die Halbwertsbreite des Maximums nicht größer ist 10 nm.
7. Lampe nach Anspruch 6, dadurch gekennzeichnet, daß die Wellenlänge des Lumineszenz-Hauptmaximums der rot lumineszierenden Komponente innerhalb eines Bereichs von 600 bis 660 nm liegt und daß die Halbwertsbreite des Maximums nicht größer ist als 10 nm.

8. Lampe nach Anspruch 6, dadurch gekennzeichnet, daß die blau lumineszierende Komponente mindestens einen ausgewählten Stoff aus der Gruppe enthält, die folgende Stoffe umfaßt: antimon-aktivierter Calciumhalogenphosphat-Leuchtstoff, Magnesiumwolframat-Leuchtstoff, titan-aktivierter Bariumpyrophosphat-Leuchtstoff und mit zweiwertigem Europium aktiverter Bariummagnesiumsilicat-Leuchtstoff.
- 5
9. Lampe nach Anspruch 6, dadurch gekennzeichnet, daß als besagte grün lumineszierende Komponente ein cer/terbiumkoaktivierter Lantanphosphat-Leuchtstoff und ein cer/terbiumkoaktivierter Magnesiumalumint-Leuchtstoff entweder einzeln oder in Kombination verwendet werden.
- 10
10. Lampe nach Anspruch 7, dadurch gekennzeichnet, daß die rot lumineszierende Komponente mindestens einen ausgewählten Stoff aus der Gruppe enthält, die folgende Stoffe umfaßt: mit dreiwertigem Europium aktiverter Yttriumoxid-Leuchtstoff, mit dreiwertigem Europium aktiverter Yttriumphosphovanadat-Leuchtstoff, mit dreiwertigem Europium aktiverter Yttriumvanadat-Leuchtstoff und mit zweiwertigem Mangan aktiverter Magnesiumfluogermanat-Leuchtstoff.
- 15

Revendications

1. Composition fluorescente utilisée dans une lampe fluorescente, comprenant un composant à luminescence rouge, un composant à luminescence verte et un composant à luminescence bleue, caractérisée en ce que le composant à luminescence bleue émet de la lumière bleue par suite de l'excitation d'une lampe à ultraviolet de longueur d'onde 253,7 nm et il a une longueur d'onde du pic de luminescence principal allant de 460 à 510 nm, une demi-largeur du pic principal d'un spectre de luminescence qui n'est pas inférieure à 50 nm, des coordonnées de couleur du spectre de luminescence tombant dans une plage de $0,15 \leq x \leq 0,30$ et $0,25 \leq y \leq 0,40$ basée sur le diagramme de chromaticité standard CIE 1931, et une réflectance spectrale qui n'est pas inférieure à 80% pour une longueur d'onde allant de 380 à 500 nm, la réflectance spectrale d'une pellicule d'oxyde de magnésium fumé étant prise égale à 100%, le rapport pondéral, dans le mélange, du composant à luminescence bleue, par rapport à une quantité totale de la composition, étant spécifié dans une région entourée par des lignes droites reliant les points de coordonnées a (5%, 2500 K), b (5%, 3500 K), c (45%, 8000 K), d (95%, 8000 K), e (95%, 7000 K) et f (65%, 4000 K) représentés sur la figure 1, points qui sont déterminés en accord avec une température de couleur du spectre de luminescence de la composition luminescente, et le composant à luminescence verte a une longueur d'onde du pic de luminescence principal allant de 530 à 550 nm et une demi-largeur du pic qui n'est pas supérieure à 10 nm.
- 20
2. Composition suivant la revendication 1 caractérisée en ce que la longueur d'onde du pic de luminescence principal du composant à luminescence rouge est comprise dans la plage allant de 600 à 660 nm et la demi-largeur du pic n'est pas supérieure à 10 nm.
- 25
3. Composition suivant la revendication 1 caractérisée en ce que le composant à luminescence bleue contient au moins un élément choisi dans le groupe constitué par un élément luminescent en halophosphate de calcium activé par l'antimoine, un élément luminescent en tungstate de magnésium, un élément luminescent en pyrophosphate de baryum activé par le titane et un élément luminescent en silicate divalent de baryum et de magnésium activé par l'europium.
- 30
4. Composition suivant la revendication 1 caractérisée en ce qu'un élément luminescent en phosphate de lanthane coactivé par le cérium/terbium et un élément luminescent en aluminate de magnésium coactivé par le cérium/terbium sont utilisés en tant que composant à luminescence verte, individuellement ou en combinaison.
- 35
5. Composition suivant la revendication 2 caractérisée en ce que le composant à luminescence rouge contient au moins un élément choisi dans le groupe constitué par un élément luminescent en oxyde d'yttrium trivalent activé par l'europium, un élément luminescent en phosphovanadate d'yttrium trivalent activé par l'europium, un élément luminescent en vanadate d'yttrium trivalent activé par l'europium et un élément luminescent en fluogermanate de magnésium divalent activé par le manganèse.
- 40
6. Lampe fluorescente comportant une pellicule luminescente (2) contenant une composition fluorescente comprenant un composant à luminescence rouge, un composant à luminescence verte et un compo-
- 45
- 50
- 55

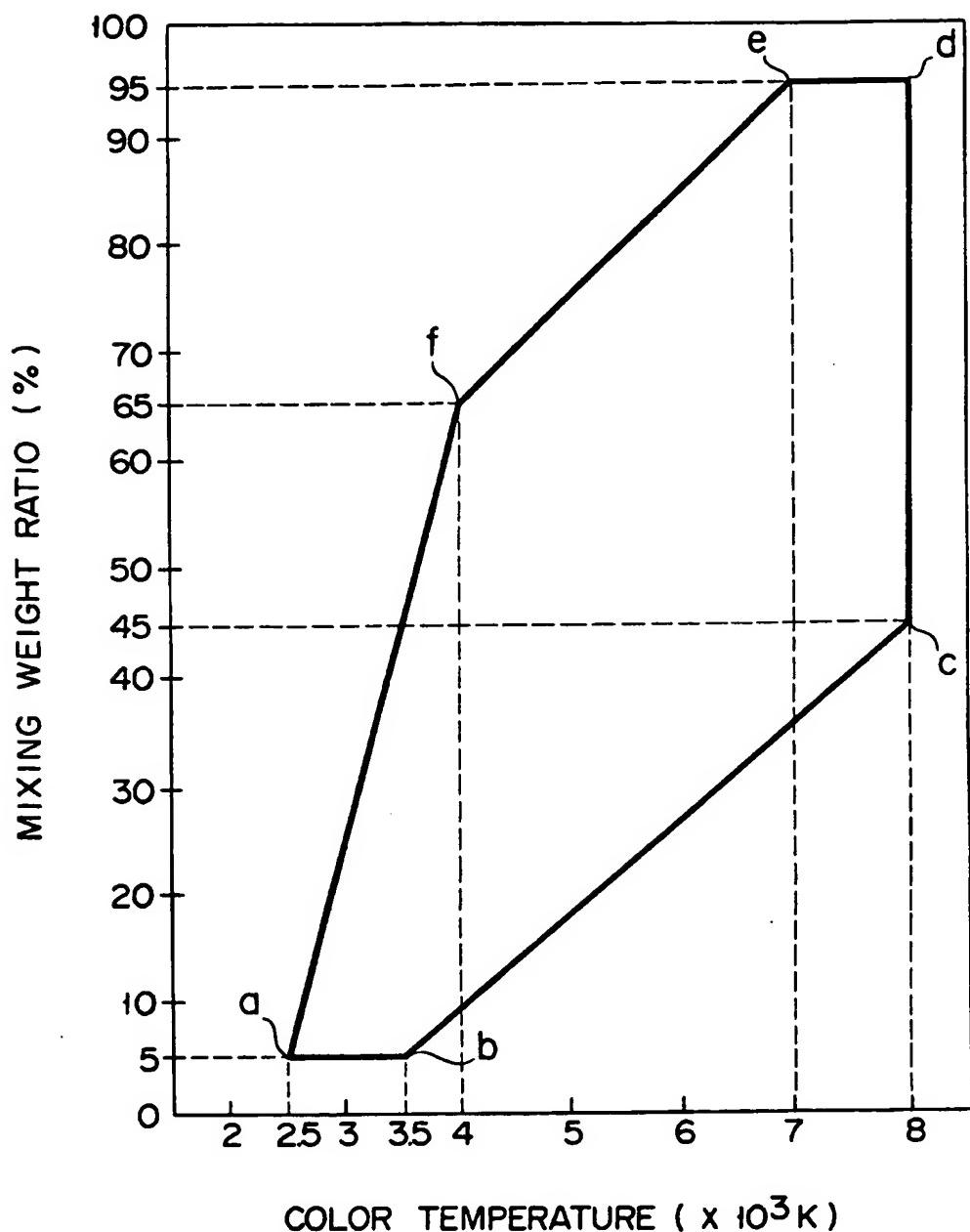
- sant à luminescence bleue, caractérisée en ce que le composant à luminescence bleue émet de la lumière bleue par suite de l'excitation d'une lampe à ultraviolet de longueur d'onde 253,7 nm et il a une longueur d'onde du pic de luminescence principal allant de 460 à 510 nm, une demi-largeur du pic principal d'un spectre de luminescence qui n'est pas inférieure à 50 nm, des coordonnées de couleur du spectre de luminescence tombant dans une plage de $0,15 \leq x \leq 0,30$ et $0,25 \leq y \leq 0,40$ basée sur le diagramme de chromaticité standard CIE 1931, et une réflectance spectrale qui n'est pas inférieure à 80% pour une longueur d'onde allant de 380 à 500 nm, la réflectance spectrale d'une pellicule d'oxyde de magnésium fumé étant prise égale à 100%, le rapport pondéral, dans le mélange, du composant à luminescence bleue, par rapport à une quantité totale de la composition, étant spécifié dans une région entourée par des lignes droites reliant les points de coordonnées a (5%, 2500 K), b (5%, 3500 K), c - (45%, 8000 K), d (95%, 8000 K), e (95%, 7000 K) et f (65%, 4000 K) représentés sur la figure 1, points qui sont déterminés en accord avec une température de couleur du spectre de luminescence de la composition luminescente, et le composant à luminescence verte a une longueur d'onde du pic de luminescence principal allant de 530 à 550 nm et une demi-largeur du pic qui n'est pas supérieure à 10 nm.
7. Lampe suivant la revendication 6 caractérisée en ce que la longueur d'onde du pic de luminescence principal du composant à luminescence rouge est comprise dans la plage allant de 600 à 660 nm et la demi-largeur du pic n'est pas supérieure à 10 nm.
8. Lampe suivant la revendication 6 caractérisée en ce que le composant à luminescence bleue contient au moins un élément choisi dans le groupe constitué par un élément luminescent en halophosphate de calcium activé par l'antimoine, un élément luminescent en tungstate de magnésium, un élément luminescent en pyrophosphate de baryum activé par le titane et un élément luminescent en silicate divalent de baryum et de magnésium activé par l'europium.
9. Lampe suivant la revendication 6 caractérisée en ce qu'un élément luminescent en phosphate de lanthane coactivé par le cérium/terbium et un élément luminescent en aluminate de magnésium coactivé par le cérium/terbium sont utilisés en tant que composant à luminescence verte, individuellement ou en combinaison.
10. Lampe suivant la revendication 10 caractérisée en ce que le composant à luminescence rouge contient au moins un élément choisi dans le groupe constitué par un élément luminescent en oxyde d'yttrium trivalent activé par l'europium, un élément luminescent en phosphovanadate d'yttrium trivalent activé par l'europium, un élément luminescent en vanadate d'yttrium trivalent activé par l'europium et un élément luminescent en fluogermanate de magnésium divalent activé par le manganèse.

40

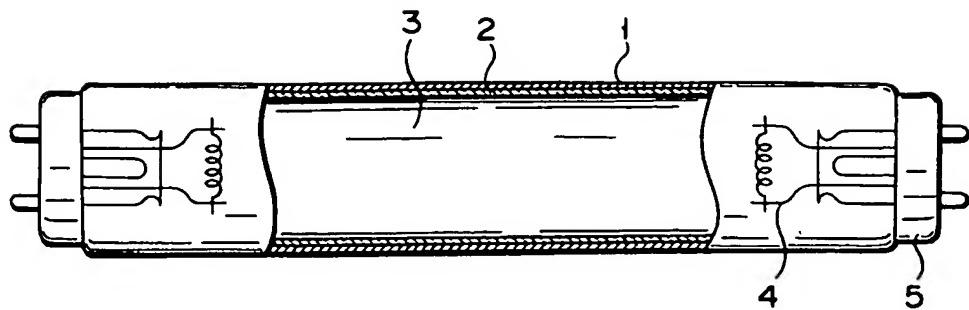
45

50

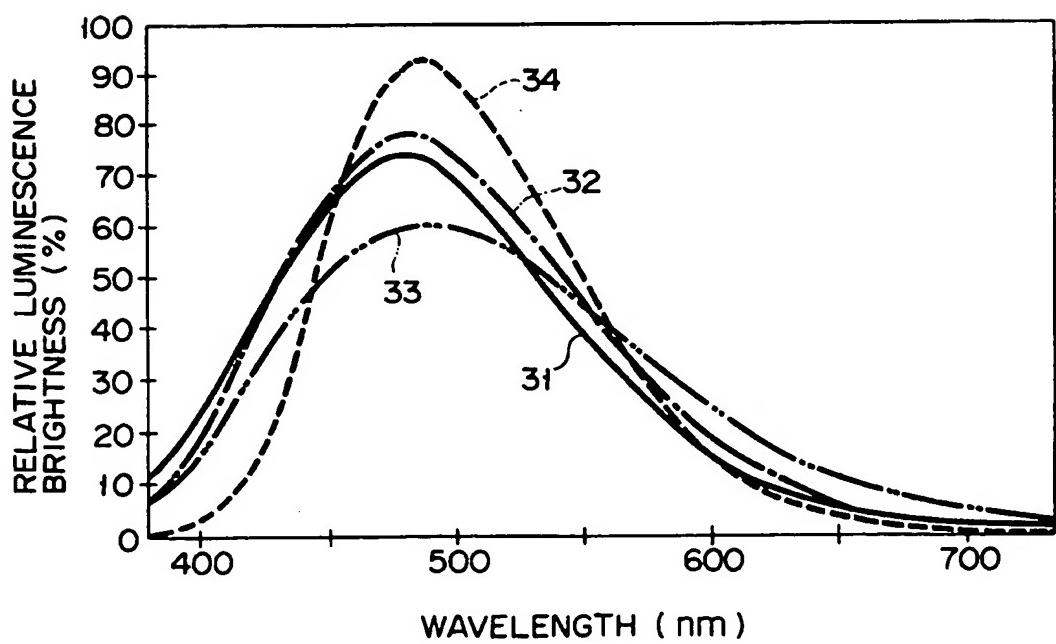
55



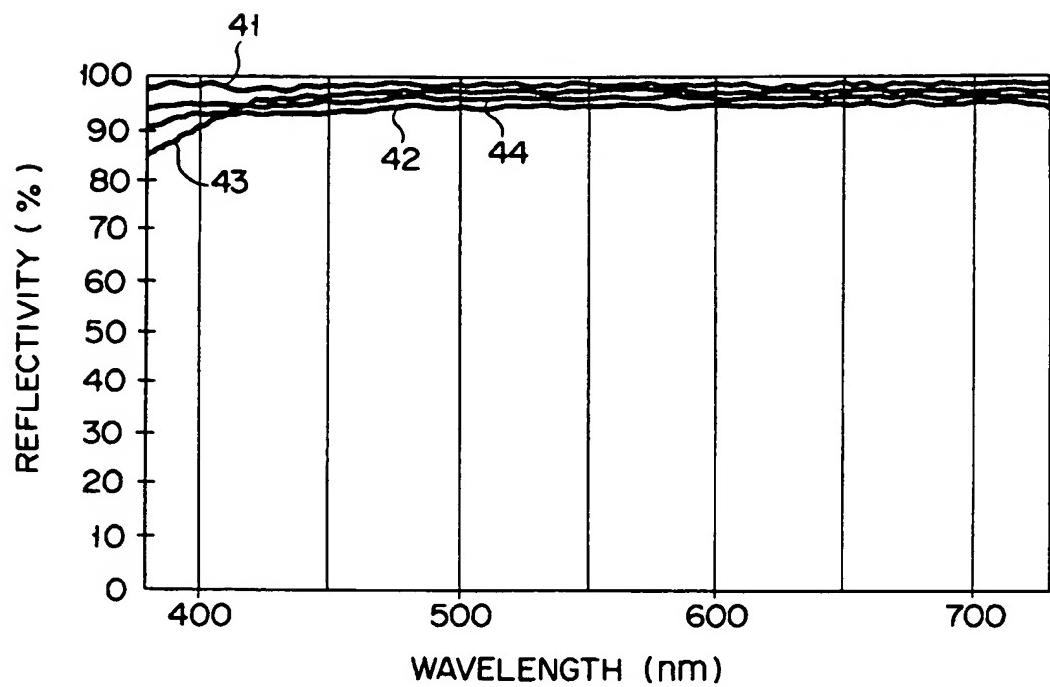
F I G. 1



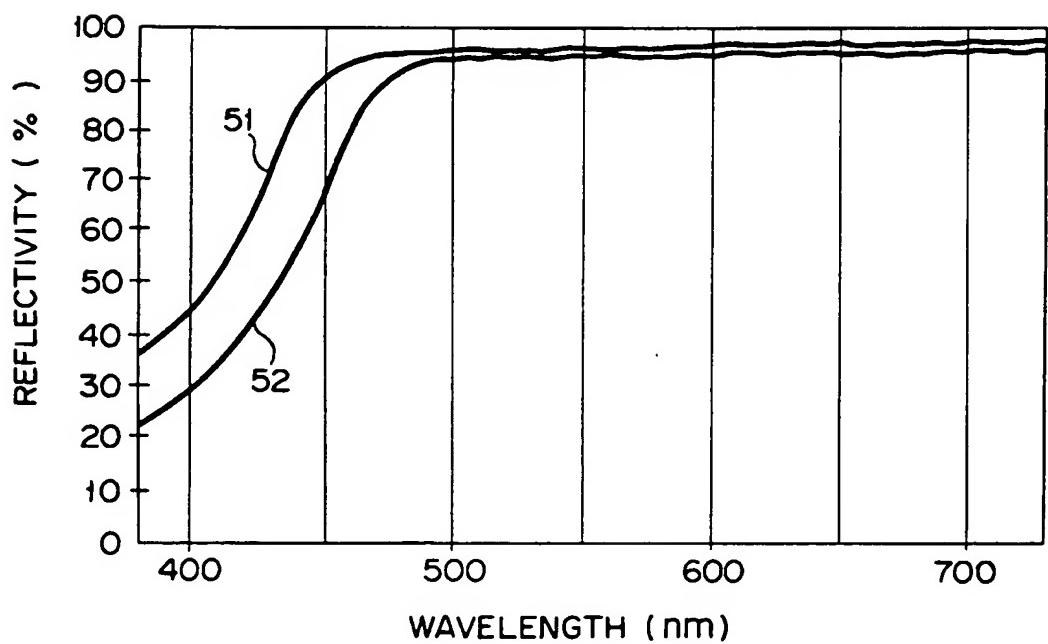
F I G. 2



F I G. 3



F I G. 4



F I G. 5